Importance of Balanced/Appropriate Fertilization on Crop Production and Soil Residual Nitrate-N/Quality

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Background

- Most soils in the Parkland and elsewhere on the Prairies are deficient in plant available nitrogen (N), many are low in available phosphorous (P), and in certain areas there is insufficient sulfur (S) or potassium (K) in soil for optimum crop growth.

- When a nutrient is lacking, it can reduce utilization of other nutrients (even when they might otherwise be at sufficient levels), resulting in poor crop yield, and nutrient- and water-use efficiency.

- This imbalance of nutrients can result in high levels of residual nitrate-N after harvest, and increase potential N loss through denitrification and leaching.

- Fertilizers are normally applied to increase crop yields, and when done properly, can balance out the utilization of all nutrients.

Methodology

Field studies were conducted in northeastern Saskatchewan to compare unbalanced versus balanced fertilization for their effects on:

- Crop yield
- Partial Factor Productivity (PFP)** (kg seed/straw/forage DMY*** ha^{-1} kg^{-1} of applied N)
- Water Use Efficiency (WUE)
- Residual nitrate-N in the soil profile.

** PFP is a measure of nutrient efficiency

***DMY = dry matter yield

Six balanced nutrient studies were conducted:

1. N and S Fertilization of Canola
2. N and S Fertilization of Wheat
3. N and Copper (Cu) Fertilization of Wheat
4. N, S, and P Fertilization of Timothy
5. N, S and K Fertilization of Grass
6. Organic versus Conventional N and P Fertilization (at Scott)

Summary of Findings

Study 1 – N and S Fertilization of Canola

- The N and S imbalance with high N and low S produced very low seed yield and PFPseed as well as relatively low oil content of canola seed.
- Compared to N alone, balanced application of N+S resulted in substantial increase in seed yield and oil content.
- Protein content generally decreased because of dilution effect from the substantial increase in seed yield.
- Residual soil nitrate-N decreased with balanced applications of N+S compared to N alone.

Study 2 – N and S Fertilization of Wheat

- N+S application increased seed yield, straw yield, PFPseed and PFPstraw.
- Residual soil nitrate-N in soil for N+S treatments were substantially lower compared to N alone.

Study 3 – N and Cu Fertilization of Wheat

- Compared to N alone, N+Cu treatments more than quadrupled seed yield and PFP_{seed} as well as produced a 6 to 10-fold increase in Cu uptake in one experiment.
- Results in the other 2 experiments were less dramatic but N+Cu treatments still resulted in substantial improvements in seed yield, PFPseed and Cu uptake over N alone.
- Residual soil nitrate-N levels decreased in N+Cu treatments throughout the soil profile (up to 90 cm deep) compared to N alone.
- This suggests that nitrate-N accumulation and leaching can be reduced considerably with balanced fertilization.

Study 4 – N, S and P Fertilization of Timothy

- N+S+P application produced the highest forage DMY and PFP.
- Residual soil nitrate-N levels in the 0-60 cm depth were considerably lower with N+S or N+P+S compared to N+P or N alone.

Study 5 – N, S and K Fertilization of Grass

- DMY was considerably higher with N+S or N+S+K treatments compared to N alone.
- PFP was approximately 4 times higher in the N+S and N+S+K treatments compared to N alone.
- Residual soil nitrate-N in the 0-60 cm depth decreased by nearly half with N+S and two-thirds with N+S+K treatments compared to N alone.

Study 6 – Organic versus Conventional N and P Fertilization

- For 6-year Rotation Cycles 1 and 2, WUE increased by 50% in the HIGH input treatment over the ORGANIC input treatment (no fertilizer input to a soil with low available P).
- Crop yields increased by 66% and 45% in the HIGH input treatment over the Organic input treatment in Rotations Cycles 1 and 2, respectively.

- Residual soil nitrate-N in the 0-90cm depth decreased by nearly one-third and one-half (in Rotations Cycles 1 and 2, respectively) in the High input treatment compared to the Organic input treatment.

Conclusions

Economic Benefit: Balanced application of N, P, K, S or Cu fertilizers is essential to maximize crop yields and to optimize nutrient, water and energy utilization.

Environmental Benefit: Balanced nutrient application can substantially reduce accumulation and leaching of nitrate-N in the soil profile, minimizing the potential for soil and ground water contamination and greenhouse gas emissions.

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